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BALFOUR'S "COMPARATIVE EMBRYOLOGY"

A Treatise on Comparative Embryology. By Francis M. Balfour, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. In Two Volumes. Vol. I. (London: Macmillan and Co., 1880.)

IT is scarcely possible to exaggerate the expressions of gratitude which are due from zoologists to Mr. Balfour for the execution of the great task which some three or four years ago he set himself. Zoologists have to be thankful to him not only for the admirable style in which he has carried out his work, but for the promptitude with which he has achieved it. Mr. Balfour's object was to produce a work in which all that has been written during the last ten or fifteen years on the structural features exhibited by animals during their growth from the egg to the adult condition should be digested, and its import carefully estimated; the result being set forth in a systematic way, so that the broad conclusions arrived at by the almost innumerable studies of "development from the egg" in all sorts and conditions of animals should be pointedly placed before the reader. At the same time he aimed to provide for the purpose of reference and for the guidance of future students something like a complete bibliography, accompanied by an analysis in many cases, of the works which have been published on special forms.

It is very well known to those who are in a position to make a comparative estimate, that during the last fifteen years in no branch of science has there been such activity, such abundance of discovery, of careful observation and ingenious speculation, as in biology; and this activity has tended more and more to concentrate itself upon the study of the mode in which the complex adult organism (whether plant or animal), with all its astounding powers and its beauty of form—slowly, surely, and yet by most improbable and devious ways, advances to its complete estate from the condition of a microscopic structureless globule of albuminous slime. This marvel of development is one which has only recently come to man's knowledge, and it seems likely that the fascination which the study of it can exert will be such as to attract the energies of an ever-increasing crowd of observers.

Mr. Balfour's book gives for those who are to come a *résumé* or summing up of the labours of those who have up to this date worked for and created our knowledge of what this process of growth from the egg is and signifies.

The first volume deals with the history of development in all groups of animals excepting the Vertebrata. The labour which it has involved will be understood when it is stated that the author gives references to five hundred and seventy-two separate memoirs or books, most of which he has thoroughly read, and from many of which he gives extracts or carefully condensed abstracts.

The thoroughness with which the subject is presented to the student may be appreciated by a consideration of the fact that two hundred and seventy-five woodcuts are given in this volume, which are, with few exceptions, prepared especially for this work, either from the author's original drawings or from the drawings of the writers whom he is summarising.

The work is divided into an "Introduction" and a "Systematic Embryology." In the Introduction we have chapters on "The Ovum and the Spermatozoon," on "The Maturation and the Impregnation of the Ovum," and on "The Segmentation of the Ovum." The systematic portion is divided into chapters, each of which corresponds with one of the large divisions of animals, *e.g.* Porifera, Platyelminthes, Rotifera, Mollusca, Chætopoda, &c.

Mr. Balfour, it is hardly necessary to say, has not performed his task as an ordinary maker of books. He is, as all zoologists know, one of the foremost students of embryology in Europe, and has added a very large proportion himself to that great heap of isolated embryological memoirs and monographs which it is the purpose of his book to condense and render accessible to a wider circle of students. Consequently we find not only new and original observations scattered here and there in the chapters of this treatise, but on the very numerous matters which call for the expression of an opinion or the exercise of judgment between conflicting statements of preceding observers, we have the conclusions, always modestly formulated, of a thoroughly competent critic.

In fact those who are already advanced in the study of embryology will find that Mr. Balfour has freely and most legitimately made use of speculative views of his own, as a series of strings on which to thread the almost innumerable observed facts which have to be put on record and kept ready, as it were, for the future building up of embryological doctrine. The reader, on the other hand, who has not yet reached the degree of knowledge at which such speculations become intelligible, will find that there is so much in Mr. Balfour's pages of hard, solid, descriptive record of the actual developmental changes of one animal after another, that he will certainly not feel cause to complain.

It would be out of place to discuss in these pages any of the new theoretical considerations which Mr. Balfour puts forward. With some of them it is possible to find fault; at the same time they are all ingeniously supported and indicate close reasoning and a large survey of facts on the author's part. They serve, as Mr. Balfour himself recognises, to stimulate inquiry, and when advanced not by a paper-philosopher, but by a most exceptionally industrious observer, they cannot fail to command respect.

If we venture to offer any remark which suggests how possibly Mr. Balfour's book might have been even more excellent than it is, it must be clearly understood that as it stands we hold it to be a perfect mine of valuable information and well-considered suggestion. We should, however, have been glad had it been possible for the author to give more attention to the history of the various stages of progress in our knowledge of embryology in general, and of each particular group. Full justice is done to recent authors, and his own contemporaries receive ample recognition from Mr. Balfour; but the successive steps by which a particular point of view has been arrived at are not always definitely indicated and due merit assigned to each of those who in past times has laboured to bring about the present phase of science. This, no doubt, has not entered into Mr. Balfour's plan on account of the additional responsibility and labour which it would have involved, and the increase in size of what is already

a voluminous treatise. But such treatment of the subject has a very high educational value and a certain ethical importance.

Further, it may be noted that the author has necessarily a difficulty to contend with in the scope itself of his book. Embryology is not a natural nor a convenient division of biological science. The study of the organism in its complete form cannot be advantageously separated from the study of the coming about of that form, and indeed it is very difficult for a writer who proposes to himself to describe the developmental changes of organisms to draw the line consistently in the various cases which he describes, and to say that at such a point his business with the organism ceases and that of the "antipædologist" begins. It is because the knowledge of embryological facts is to so large an extent new, that separate treatises on embryology are necessary. It is as a supplement to treatises on the structure or anatomy of animals which do not sufficiently deal with embryology that such a distinct treatise is needful, and such need is merely the result of the late development of embryological research.

In the course of time we shall no doubt see a complete fusion of "embryology" and "antipædology"—the facts of structure to be observed in the youth and in the maturity of organisms being treated as a matter of course concurrently. Nothing could conduce more directly to this desirable state of things than the really remarkable and successful effort which Mr. Balfour has made to gather together and present in a compact and logical form the embryological results which have been and still are pouring forth from Russian, German, English, French, and American laboratories in an overwhelming stream, calculated to daunt by its velocity any but the most determined student. E. RAY LANKESTER

THE SIEVE-TUBES OF DICOTYLEDONOUS PLANTS

Beiträge zur Kenntniss des Siebröhrenapparates dicotyler Pflanzen. Von Dr. Karl Wilhelm. (Leipzig: W. Engelmann, 1880.)

IT is perhaps natural, owing to its peculiarities, and especially to the character of the cell walls, that the soft bast was comparatively lately investigated and described;[1] but it is surely a surprising fact that the ground should have been left open till the present year, for a thorough investigation of the development of those tissues which are characteristic of the phloem.

In the "Comparative Anatomy" of De Bary we find a full account of what was known in 1877 of the structure and development of the soft bast; at the same time the writer pointed out several questions concerning which further investigation was required. He drew especial attention to our want of knowledge of the relation of the cambiform cells[2] to the sieve-tubes, and of the development of the sieve plate, the callus mass, and the contents of the sieve-tube. It has been the object of Dr. Wilhelm's researches to supply information on these several points; while at the same time he affords us many other interesting details.

Owing to the wideness of the subject it was impossible for the author to extend his researches beyond a limited number of types. Those selected were *Vitis vinifera*, L., *Curcubita pepo*, L., and *Lagenaria vulgaris*, Ser. It will be seen that Dr. Wilhelm has selected plants having sieve-tubes of the two different types common among the Dicotyledons, viz., Cucurbita and Lagenaria where the structure is more simple, Vitis where it is complicated by the presence of several sieve-plates side by side on the same cell wall. In a note at the end of the paper the author specially asserts that his results only apply to the plants named; while further research must show whether the structure described is really typical.

The main results arrived at are as follows:—Those formative cells of the bast which are set apart for the development of a member of a sieve-tube, usually suffer a longitudinal division into two unequal cells: the larger forms one member of the sieve-tube; the other, which is smaller and shorter, develops into the companion-cell (*Geleitzelle*). The latter may, in Cucurbita and Lagenaria, again divide. The walls separating the companion-cells from the sieve-tube are fitted, and the cell contents richly protoplasmic. It will be seen that these cells, being sister cells of the members of the sieve-tubes, must be distinguished from the larger cells, which are usually termed "cambiform;" these latter being formed by division from formative cells of the bast, but not being in direct genetic connection with the cells, which develop into members of the sieve-tubes.

Dr. Wilhelm finds that the "callous" condition of the sieve-plate is not, as previously supposed, the result of a secondary change of the plate; on the contrary, the differentiation of the sieve-plate begins by the change of the cellulose to "callus" at a number of points. It is in the callus masses, formed at these points, that the pores of the sieve later appear. The callus may extend itself from these points so as to cover the whole face of the plate, and completely inclose the cellulose sieve. A callus-skeleton is thus formed which may be isolated.

The callus varies in volume, increasing with age, or on approach of the period of rest; in which case the pores may be completely stopped; or decreasing as the period of summer activity approaches, when the pores are again opened. This result may be obtained by artificial means. It is best seen in Vitis; it is probable that this variation of volume of the callus is by no means universal.

As regards the substance of the callus it will be seen from the following reactions that it cannot be identified with any of the substances previously described. With acids and alkalies it swells quickly; if the reagents be strong it is dissolved. Ammoniacal sub-oxide of copper attacks it only slightly, or not at all; by use of this reagent the callus-skeletons before mentioned may be obtained free. Solution of iodine in alcohol does not colour it; solution of iodine in potassium iodide colours it yellow to brownish yellow. This with Schultz's solution gives a deep red brown; when used alone the latter reagent gives no colour, but causes considerable swelling.

Thus far we have only discussed the cell walls. While the development of the sieve has been going on, but before the perforations are formed, a change appears in

[1] The sieve tubes were discovered by Hartig (1837). His observations were many years after verified by other observers, especially von Mohl, Nägeli, and Hanstein.

[2] De Bary, "Vergl. Anat.," p. 337.